Developing Advanced Broadband Microwave Detectors for Next-Generation CMB Polarization Studies

Completed Technology Project (2015 - 2018)

Project Introduction

The photons of the cosmic microwave background (CMB) stream toward us from the boundary of the observable universe and arrive with information about both their point of origin and the contents of the space in between. Fully extracting this information requires measuring not only the energy and arrival direction of these photons, but also their polarization. My proposal is to develop fast, robust, and extremely sensitive polarization detectors (and arrays of such detectors) for future ground-based and satellite missions to accurately map the celestial polarization. The knowledge we will thereby gain extends from the first moments of the universe (and the theory of its exponential expansion) to the statistical distribution of galaxies and galaxy clusters (from which we can derive information about dark matter and dark energy). The two complementary designs I am pursuing share the goal of collecting more photons while maintaining low detector noise and stable equilibrium temperatures under the cryogenic conditions in which they are operated. Achieving these goals requires characterizing the responses of the detectors and arrays and understanding the results through a model of the behavior. I will model thermal energy transfer between the detector or array elements, and use these models to predict and understand their response to electrical and optical input signals. Successful models can then be used to optimize detector and array properties in tandem with measurements of the optical coupling efficiencies of the detectors. I will also contribute to the eventual implementation of these devices in the field, and to the analysis of the data they produce. The science goals of these CMB missions align with those outlined in the 2010 National Research Council decadal survey, while elements of the detector design would themselves prove useful in other space technology applications requiring sensitive photoreceptors.

Anticipated Benefits

This project aims to develop fast, robust, and extremely sensitive polarization detectors (and arrays of such detectors) for future ground-based and satellite missions to accurately map the celestial polarization. The knowledge we will thereby gain extends from the first moments of the universe (and the theory of its exponential expansion) to the statistical distribution of galaxies and galaxy clusters (from which we can derive information about dark matter and dark energy).

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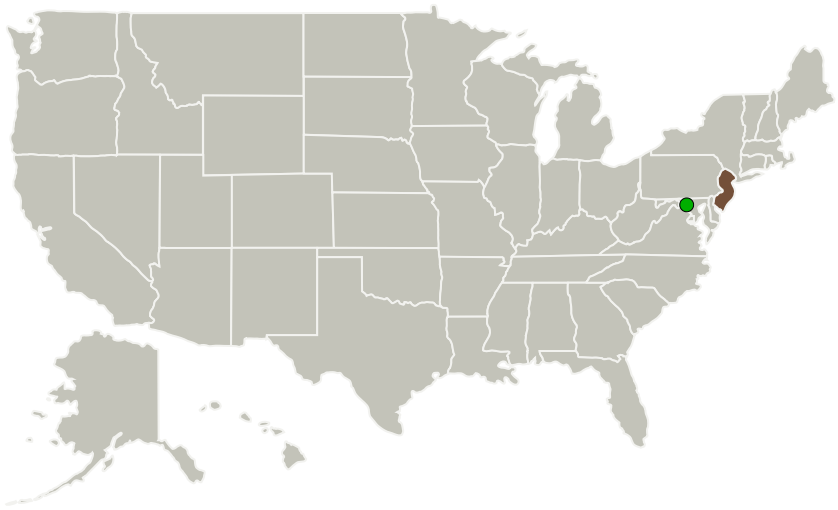
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Princeton University	Lead Organization	Academia	Princeton, New Jersey
Goddard Space Flight Center(GSFC)	Supporting Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations
New Jersey

Project Website:

https://www.nasa.gov/strg#.VQb6T0jJzyE

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Princeton University

Responsible Program:

Space Technology Research Grants

Project Management

Program Director:

Claudia M Meyer

Program Manager:

Hung D Nguyen

Principal Investigator:

Suzanne Staggs

Co-Investigator:

Kevin T Crowley

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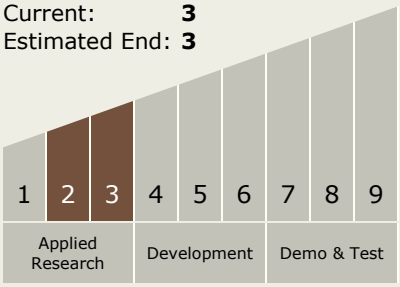
Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.1 Remote Sensing Instruments/Sensors
    - TX08.1.1 Detectors and Focal Planes

Target Destination

Others Inside the Solar System